# COMMUNICATIONS SYSTEMS

The present invention relates to communications systems, and in particular, to digital communications systems.

## BACKGROUND OF THE INVENTION

Typical current digital communication systems often use non-constant envelope modulation schemes, e.g. the new system EDGE (Enhanced Data rates for GSM Evolution) uses $3\pi/8$-8PSK modulation. This means that some part of the information lies in the amplitude (envelope) of the transmitted signal and some part lies in the phase of the transmitted signal. In other words, this is a combination of Amplitude Modulation (AM) and Phase Modulation (PM).

The non-constant envelope makes feedback power control more difficult than for modulation types with constant envelope (e.g. GMSK modulation used in GSM). The reason is that the varying amplitude causes variations in power. Since the amplitude depends on the symbols that are sent, the measured power could vary between time-slots that are sent with the same nominal output power, i.e. the measured power could vary although the power control signal to the amplifier in the transmitter remains constant.

## SUMMARY OF THE PRESENT INVENTION

It is emphasised that the term "comprises" or "comprising" is used in this specification to specify the presence of stated features, integers, steps or components, but does not preclude the addition of one or more further features, integers, steps or components, or groups thereof.

According to one aspect of the present invention,

there is provided a method for controlling power output of a radio frequency transmitter, wherein information relating to statistical variations in the amplitude of the information signal that is to be transmitted is used to control a gain value of the radio frequency transmitter.

Embodiments of the invention described below take the statistical amplitude variation of the non-constant envelope modulation into account, and compensate for it. The control signal to the amplifier will therefore not be influenced by the amplitude variations in the modulation signal. Of course, changes in transmitter gain because of e.g. temperature variations etc. will be tracked and compensated for in the power control loop.

The principles of the invention can be applied in TDMA (Time Division Multiple Access) systems with non-constant envelope modulation. An example of such a system is the above-mentioned EDGE system.

## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram illustrating one embodiment of the present invention;

Figure 2 is a block diagram illustrating part of the embodiment of Figure 1; and

Figure 3 is a block diagram illustrating a second embodiment of the present invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 illustrates a first embodiment of the present invention which comprises a waveform generator 1 which produces a first output signal c1. The output signal c1 is supplied to a radio frequency circuit 3 which converts the signal c1 into a radio frequency signal r for transmission from an antenna 4. The

operation of the radio frequency circuit 3 is well known, and so a more detailed explanation will be omitted for the sake of clarity.

An attenuator 6 detects the radio frequency signal r to provide an attenuated signal a. The attenuated signal a is supplied to a power sense circuit 8 which produces a signal y which is proportional to the power of the attenuated signal a. The power sense circuit 8 may be, for example, an envelope detector.

A second output signal c2 from the waveform generator 1 is also supplied to a measurement unit 10 which operates to calculate the mean power level of the generated signal c2. The second signal c2 may be identical to the first signal c1, or one of the signals c1 and c2 may be a time delayed version of the other. The mean power of the signal c2 is calculated or measured to form a mean power signal $m_{mean}$ (in dB). The signal $m_{mean}$ represents the mean power of the actual symbol sequence being sent in the current burst. The difference between $m_{mean}$ and a reference signal $m_{ref}$ (in dB) results in a difference signal $\Delta$ (in dB) being output from a signal combiner 12. The value of the reference signal $m_{ref}$ could for example be chosen to represent the mean power of a very long symbol sequence in which all symbols have the same probability. The value $\Delta$ is a number which represents how much the power of the signal r can be expected to differ from a required level $P_{req}$, when the actual symbol sequence (burst) is sent. A signal $P_{req}$ relating to the requested power level and value $\Delta$ are supplied to a level control block 14 to form a reference value, x.

As mentioned above, a portion of the RF (Radio Frequency) signal, r, is taken from the radio frequency circuitry. The signal r is attenuated in the attenuator 6 to form the signal a. The signal y of the

power sense unit 18 is proportional to the power of the signal a.

The signal y is compared with the reference signal x by subtracting y from x using a combiner 16. The signal x is calculated (or measured) prior to the burst of information which is to be transmitted from the radio circuitry. The signal x is then present during the whole burst. The difference between the signals x and y forms an error signal e. The error signal e is calculated once per data burst. The error signal e is supplied to a power controller 18, which forms a control signal u. The signal u determines the gain to be used during the next data burst of an amplifier included in radio circuitry 3. Such a system provides automatic compensation of statistical variations in the amplitude of the information signal that is to be transmitted, and so these variations become "invisible" for the power control loop.

Figure 2 illustrates the level control unit 14 of Figure 1 in more detail. The level control unit 14 includes an adder 20 which produces a signal in decibels (dB) which corresponds to the required power level $P_{req}$ (in dB) added to the difference value $\Delta$ (in dB). A logarithmic to linear converter 22 is provided to convert the decibel (dB) signal output from the adder 20 to a linear signal.

Figure 3 illustrates a second embodiment of the invention in which the attenuation of the attenuator 6 is dependent of the requested nominal power level, $P_{req}$. Preferably the attenuation is proportional to the $P_{req}$ signal. In this way, the attenuated power level signal a supplied to the power sense block 8 does not change much from one burst to another. This reduces the dynamic range requirement of the power sense block 8.

Merits of the invention are listed below:

- Automatic compensation of statistical variations in the amplitude of the information signal that is to be transmitted, so that these variations become "invisible" for the power control loop.
- In one of the embodiments (see Figure 3) of the invention, the dynamic range requirement on the output power detector is decreased.